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## Digital Radio Strategies in the United States: A Tale of Two Systems

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## [1] Chapter Six

### **Digital Radio Strategies in the United States: A Tale of Two Systems**

Alan G. Stavitsky

Michael W. Huntsberger

The case of digital radio in North America illuminates the contradiction between federal communication policy ideals and *realpolitik*. The policy of the United States government gives official imprimatur to robust competition and to local broadcasting that serves ‘the public interest, convenience or necessity,’ in the words of the federal licensing standard (Radio Act of 1927). In the decades since the passage of the Federal Radio Act, notions of capitalism and communication have intertwined as they have been set down in the re-conceptions and revisions of the original statute. Within the local marketplace, the theory goes that unfettered capitalism will lead to efficient exchange of goods and services, while free and open discourse will yield the best ideas to promote the democratic process (Stavitsky 1994). On the foundation of this theoretical model, broadcast stations in the United States have always been licensed at the level of the local community. To ensure competition, regulators have historically set and enforced limits on the number of stations any individual or agency could own.

Broadcast regulation in the United States, however, has long been marked by tension between the ideals of localism and competition, and the lure of centralization. While

national broadcasting systems dominated the development of European radio, U.S. radio began in the early 1920s with independent local stations drawing upon local voices. The rhetoric of the time reflected utopian notions of radio as a conduit of civic discourse through which citizens would deliberate the public affairs of the community. In practice, however, network broadcasting developed rapidly and the ‘chains’, as the first national broadcasting corporations were originally known, became the dominant source of programming within radio’s formative first decade. In addition to this centralization of content, control of stations became increasingly concentrated as broadcasters successfully lobbied for gradual relaxation of ownership limits. For radio, this deregulatory trend culminated in passage of the Telecommunications Act of 1996, which eliminated all restrictions on national ownership, while retaining limits within any particular market (Telecommunications Act of 1996).

This capsule history points to the ambiguity of U.S. communication policy. The focus of regulation remains on local service, while content and control are largely centralized. Though the metaphor of the ‘marketplace of ideas’ implies robust competition, ownership has been allowed to concentrate. Further, the Federal Communications Commission, while seeking to bring the benefits of new technology to industry and public, has historically been reluctant to set technological standards, preferring to let the market decide. At times this lack of symmetry between regulators and industry has had significant consequences. The commission’s failure to set standards for AM stereo systems in the 1980s helped doom the technology to irrelevance (Sterling and Kittross 2002: 570). Similar ambiguities have characterized the emergence of digital radio, as

U.S. regulators have been unprepared or unwilling to face the challenges presented by new technologies, and have consistently deferred to industrial imperatives as they established a policy framework.

## **[2] Stumbling toward a digital radio standard**

Initiatives to migrate broadcast radio in the United States from analogue to digital systems began in the early 1980s, concurrent with similar efforts in Europe and Asia. With the introduction of audio compact disc players to the consumer market in 1982, U.S. broadcasters sought methods to upgrade the audio quality of their services in order to provide CD-quality sound (Radio World 2008). Broadcast transmission and reception systems of the time were inadequate for the task, leading to a variety of experimental approaches to ‘going digital’. To accommodate the additional bandwidth necessary for digital encoding and transmission, Boston public radio station WGBH experimented with modulating a digitized audio programme stream on the licensee’s UHF public television channel. While the experiment was considered successful, the broadcasts were available to an audience of perhaps a few hundred people who owned professional digital audio processors. WGBH was also among the first to use digital systems to distribute programme material between remote and head-end facilities (Bunce 1986: 21).

During this period of digital experimentation, the historic regulatory structures and policies that had governed U.S. broadcasting since the 1930s were undergoing fundamental and profound change. With the inauguration of President Ronald Reagan and the subsequent appointment of Mark Fowler as chair of the Federal Communications

Commission in 1981, broadcasting licenses that had been rigorously regulated by the F.C.C. became commodities that could be easily traded on the open market. Widely credited for referring to television as ‘a toaster with pictures’, Fowler de-emphasized the Commission’s policy research and recommendation functions in favour of market-based solutions derived from the practices of industry (Boyer 1987: C15). Notable for decisions that eliminated requirements for public service programming, lowered standards for license renewal and removed restrictions on the sale of licenses, the F.C.C. under Fowler nurtured an environment that encouraged private interests to take the lead in the development of digital broadcasting in the United States.

The challenge emerged in 1990, as the F.C.C. considered whether to authorize both terrestrial and satellite-delivered digital radio services. Somewhat surprisingly, the first initiative to come before the Commission did not originate with one of the major U.S. broadcasting companies or equipment manufacturers, but from a start-up: Satellite CD Radio Inc. petitioned the F.C.C. to allocate space in the S-band between 12.2 and 12.7 GHz for the transmission of signals to geostationary earth-orbiting satellites capable of transmitting a nationwide, multi-channel digital audio service directly to consumers. The Satellite Digital Audio Radio System [S-DARs] – satellite radio – would be available throughout the continental United States, allowing the consumer to travel coast to coast without experiencing interference or service interruptions (Huntsberger 2001). Charging that the Satellite CD plan threatened the local service of 12,000 terrestrial radio broadcasters, the National Association of Broadcasters asked to F.C.C. to dismiss the application. At the time, the president of Satellite CD observed that the commercial

broadcasters were not motivated by aspirations to preserve the traditions of local service or the public interest, but rather by the more essential desire to restrict competition (New York Times 1990: D4).

On behalf of its members, the vast majority of whom are commercial enterprises, the N.A.B. considered a variety of systems that could be capable of providing CD-quality digital audio broadcast services, including delivery by cable, satellite, and terrestrial channels. As the World Administrative Radio Conference moved toward adoption of the DAB system, the N.A.B. was pushing for the adoption of the Eureka 147 system as the U.S. standard (New York Times 1991: 115). But L-band DAB faced a host of challenges. Because Eureka 147 was suitable for terrestrial and satellite transmission, existing broadcasters feared that the technology might provide parity for S-DARS. In addition, broadcasters viewed the multiplex capability of Eureka 147 as an opportunity for new terrestrial competition, and worried that Eureka 147 allocations might not match existing coverage.<sup>i</sup> Public agencies had other concerns. Following the success of Operation Desert Storm, a coalition of forces in the administration of George H.W. Bush moved to protect the L-band for the use by the U.S. Department of Defense for ‘aeronautical flight-test telemetry’ for the development of new, advanced weapons systems (Belsie 1992: 9).

As the debate over spectrum allocation and transmission standards proceeded, an initiative developed jointly by commercial ownership groups CBS Radio, the Gannett Company and Group W Broadcasting proposed a system that would allow for simultaneous transmission of analogue and digital signals on existing FM frequencies,

and possibly on AM channels as well. Such an in-band on-channel [IBOC] system offered the possibility that the move from analogue to digital technology could be accomplished without any dislocation to the existing marketplace for broadcast radio programming and advertising. Specifically, the IBOC system promised existing licensees the chance to enhance the sound of their broadcasts and carry additional services on their signals without opening channels for new competitors. But it would not be easy: one CBS executive compared the challenge to ‘fishing out millions of needles every second from an endless line of haystacks’ (Andrews 1992: D8).

Throughout the 1990s, the N.A.B. considered several approaches to IBOC digital radio. But the primary policy agenda for commercial radio broadcasters was characterized by their united and vocal opposition to satellite radio. At every turn, the N.A.B. asserted the position that nationwide satellite services would undermine the ability of local broadcasters to ‘attract listeners, sell advertising and maintain their viability’ (Andrews 1992: D1). While engineering trials for satellite broadcasting proceeded smoothly, the progress of satellite radio in the sphere of public policy slowed to an almost glacial pace. The F.C.C. asserted that ‘existing radio broadcasters can and should have the opportunity to take advantage of new digital radio technologies’, and acknowledged industry concerns that the national footprint of satellite radio posed a competitive threat to local stations, reaffirming localism as a ‘touchstone value’ (F.C.C. 1999: 4). At the same time, while recognizing the terrestrial and satellite services ‘would compete to some extent’, the Commission concluded that satellite radio would complement broadcast radio ‘by providing regional and national services’, and that IBOC DAB was not yet technically

feasible. Backed by arguments for technology advancement and market diversity, the proponents of satellite radio ultimately succeeded, convincing the F.C.C. to allocate spectrum and consider license applications from four private companies (Andrews 1995: D14). Two of these companies survived as XM Radio, launched in November 2001, and Sirius Satellite Radio, launched in 2002 – the dramatic launches garnering considerable attention from the press and investors on Wall Street. Though they were separate and competing companies, the fates of the two digital services would remain connected.

Faced with the realities of competition, the N.A.B. moved ahead with efforts to develop a workable IBOC system. It would be nearly four years until the CBS-Gannett partnership, operating as USA Digital Radio, filed the first Petition for Rulemaking with the F.C.C. to permit IBOC as the terrestrial digital radio broadcast standard in the U.S (Desposito 1999: 45), and another three years before the Commission approved an IBOC system for use in the United States (Feder 2002: C3). While IBOC on the FM band received the approval of the National Radio Systems Committee, the influential engineering group could not endorse similar technology for AM broadcasting, citing night-time interference problems. Because one of the selling points of IBOC had been improved fidelity for AM broadcasters on a par with FM-band signals, any strategy that might move forward with FM-IBOC only was questionable. Nevertheless, IBOC was presented to broadcasters with great fanfare at the 2002 NAB convention as a fully operational system and approved by the F.C.C. later that year, despite AM transmission problems and a lack of testing with consumer receivers.

Significantly, the Commission's decision did not include a calendar mandate for digital conversion. With a tip of the hat to former Chairman Fowler's bedrock belief in the power of free markets, regulators followed the preferences of industry leaders and turned to the forces of supply and demand to catalyze the adoption of digital radio in the U.S. The approved IBOC system would be manufactured and distributed exclusively by iBiquity Digital, and available only under license from the manufacturer. The rush to market was driven by a desire to reassure Wall Street of the continued viability of terrestrial radio in the digital age, even as satellite radio systems and services began to appear in the consumer market (Ala-Fossi and Stavitsky: 2003).

As commercial radio interests took more than a decade to roll out their chosen digital system, a variety of chipmakers and equipment manufacturers capitalized on the slow, deliberate pace of IBOC development. Motorola, Blaupunkt and Texas Instruments were among the companies that developed technologies for digitizing, filtering and manipulating analogue radio signals to improve reception and audio quality (Feder 2002: C2). The public release of the World Wide Web allowed stations to deliver digitally-encoded audio programming directly to personal computers, and created a global delivery platform for audio content and services. Software designers developed algorithms that reduced the size of digital audio data files so they could be economically captured, manipulated, stored and retrieved by personal computers, without apparent loss of sound quality. By 2001, when Apple released the iPod portable player and the iTunes software that allowed consumers to easily select, purchase, store, and replay thousands of digitally encoded songs on demand, the consumer market for audio media had entirely outstripped

the scenarios envisioned by U.S. commercial broadcasters, and the N.A.B. Satellite radio had become just one of a host of digital audio technologies and services competing with terrestrial radio for the attention of American consumers.

The symbiosis of the terrestrial and satellite digital systems re-emerged with the 2008 merger of XM and Sirius into a single, corporate entity. When the F.C.C. issued the original licenses to the two companies, it did so with the stipulation that one company would not be permitted to acquire control of the other. This stipulation was intended to ensure competition and mollify terrestrial broadcasters, but once the business plans of the two companies were set into motion, both satellite providers saw their operating costs soar like their respective launch vehicles, and eventually Sirius and XM sought government approval to merge in 2006. This led to eighteen months of official deliberation by the U.S. Justice Department which considers anti-trust matters. At issue was the definition of market; were XM and Sirius in effect competing with local radio stations, transmitting from 25,000 miles up? Viewed in this way, a satellite radio monopoly could create a formidable challenge that threatened the economic viability of local terrestrial broadcasters and, by extension, the bedrock value of localism.

But Sirius and XM argued that satellite radio is simply another aural alternative in an audio marketplace that includes not just terrestrial radio, but also Internet audio services, iPods and other digital players, and audio-enabled cell phones. The Justice Department, and eventually the F.C.C., took the latter view, ruling that the merger would not hurt competition. 'In several important segments of their business, with or without the merger,

the parties simply do not compete today,' said Thomas O. Barnett, head of the Justice Department's anti-trust division. 'Some people may view iPods as a particularly good alternative. They may view HD radio as an alternative' (quoted in Philip Shenon, 3/25/08, NYT, Justice Dept Approves XM Merger with Sirius). As Sirius and XM move to combine their operations, sales, marketing and customer service functions, the short-term benefits of the merger will accrue first to the business enterprises. For consumers, the full value of a combined service and its competitive impact on the market, will not be apparent until receivers capable of picking up both satellite services become available, perhaps in the next year (Pizzi 2008: 42).

## **[2] Playing catch-up**

Given the long road to IBOC implementation, U.S. radio broadcasters have moved relatively quickly to bring the technology to market and stimulate consumer interest. Capitalizing on burgeoning interest in the federally mandated conversion to High Definition Television [HDTV], iBiquity rechristened the IBOC system as HD Radio.<sup>ii</sup> By October 2003, 280 stations in more than 100 markets had purchased licenses for HD Radio technology, and but only 70 were broadcasting digitally encoded FM signals (Berger 2003: G3; iBiquity 2003). HD Radio-capable home receivers appeared at the 2004 Consumer Electronics Show, and several automobile manufacturers carried HD Radio receivers in their 2004 models. But consumer interest was marginal at best. The receivers were expensive: Kenwood's KTC-HR100 add-on tuner for car stereos carried a price tag of \$350 (Berger), far more than add-on units for satellite radio, and a substantial price to pay for CD-quality audio in the listening environment of a moving car with an

80+ dB noise floor. HD receivers designed for home use entered the market with retail prices of \$500 or more (Fleishman 2005: C11). More recently, prices for home and auto receivers have moderated, with some units now costing less than \$100 (iBiquity 2009). However, power requirements for HD chips exceed specifications appropriate for personal devices, and no manufacturer currently offers a portable HD unit that can complement or compete with Apple's iPod and similar digital players, shutting HD broadcasters out of this most significant market.

Faced with such challenges, in 2005 some of the largest commercial radio companies in the U.S., including Clear Channel Radio, Entercom and Infinity Broadcasting, formed the HD Digital Radio Alliance, a co-ordinated, national strategic marketing campaign to 'accelerate the rollout of HD Digital Radio' (HD Digital Radio Alliance 2005).

Paradoxically, the campaign was undertaken at a political level in the name of protecting the U.S. ideal of locally focused and controlled radio stations, despite criticism that the consortium violates anti-trust law. The strategy of the Alliance positioned HD in opposition to satellite radio, offering a parallel benefit – programme diversity – without the cost of a satellite radio subscription. Beginning with radio spot advertising on 280 stations in 28 markets, valued at \$200 million, the campaign touts the benefits of HD to listeners, and promoted the availability of receivers for new and existing cars and homes (HD Alliance 2006). The effort provides broadcasters with logos, brochures, print ads, web banners and other graphic materials, an audio podcast, a video with tips for consumers, and links to rebate offers from HD radio manufacturers and dealers (HD Alliance 2009).

While the Alliance touts the efficacy of these efforts, a 2007 study by independent research firm Bridge Ratings concludes that market penetration by HD radio lags far behind competing technologies, especially analogue AM and FM radio, which continues to serve over 90% of Americans each week. iPods and other digital players reach 30% of the population, and satellite radio penetrates almost 5%. In comparison, HD Radio reaches less than 1% of Americans: Bridge estimates that 450,000 Americans listen to HD radio every week, compared to 57 million that listen to some form of Internet radio (Bridge Ratings 2007). One analyst asserts that the steady, deliberate promotional strategy of the Alliance is ‘difficult to support’. Such a long-term, continuous campaign is perhaps the hardest type of promotional exercise to undertake successfully, as opposed to the sort of short-term, high-visibility strategies that are preferred by marketing professionals (Pizzi 2008: 15). These developments suggest that HD radio has a long way to go to catch up with other digital audio technologies available in the U.S.

U.S. public radio broadcasters have focused primarily on the feasibility of using the secondary audio channels [SACS] on HD Radio signals to provide additional programme services to niche audiences. Throughout 2003, field tests conducted by NPR Labs examined the performance of HD channels carrying two programme streams. The findings of the Tomorrow Radio Project demonstrated that spectrum split into two streams was sufficiently robust to provide high-quality reception in mobile environments (NPR Labs 2004). In subsequent years, NPR Labs has become a leader in HD Radio research, publishing findings on coverage and interference.

Digitization also offers the promise of new public-service applications. Many public radio stations use their analogue sidebands to broadcast programmes for visually impaired listeners, but these ‘radio reading services’ require distribution of specially equipped receivers. HD Radio accommodates these services on multicast side channels (though this does by necessity still require listeners to obtain a digital receiver). Further, NPR Labs, the research-and-development wing of National Public Radio, collaborated with Harris Corporation, a U.S. communication equipment manufacturer, and Towson University engineers to develop an audio-captioning system that does, in effect, subtitle radio programming for hearing-impaired people (CITE). The system was demonstrated in live coverage of the U.S. presidential election returns in November 2008 (‘Captioned radio broadcast to enable millions of deaf and hard-of-hearing to experience NPR’s live coverage of presidential election for the first time,’ 21 October 2008, news release, International Center for Accessible Radio Technology, <http://I-cart.net>).

## **[2] International concerns**

Presently, no nation or governing body beyond the United States has considered HD Radio as a standard for digital broadcasting. Yet the nation’s position as a dominant economic and political power, and one of the world’s largest markets for broadcasting technology for consumers and professionals, presents considerable challenges and opportunities for other digital radio interests around the world. In addition, the U.S. shares two borders; one with Canada totaling almost 9,000 kilometres, and one with Mexico of just over 3,000 kilometres. This shared geography poses a number of issues

related to spectrum allocation, cross-border interference, and the availability of services and equipment in professional and consumer markets.

For many years, Canada embraced the Eureka 147 DAB standard for the transition to digital radio broadcasting. But a 2006 report on the future of broadcasting in Canada recognized that analogue FM remained a dominant form of radio, and that Canadian broadcasters have ‘adopted new technology platforms through Internet streaming and podcasting, as well as entering into content partnership arrangements with other undertakings including satellite providers’, particularly those based in the U.S. (O’Neill 2008: 32). Recognizing the new realities in the digital audio marketplace, the Canadian Radio-Television and Telecommunications Commission revised the nation’s digital radio policy to consider DAB as one of a number of appropriate technologies, including HD Radio that might be adopted in Canada. The CRTC also announced it was prepared to authorize IBOC services in Canada (Radio 2006). Field trials conducted in Toronto in 2007 concluded that the technology poses interference problems for existing analogue FM services, and that implementation will have to be accompanied by review and revision of spectrum management rules (Bouchard 2007). Mirroring the U.S. experience, the Bouchard report observes that consumers will ultimately decide whether HD services will be viable in Canada. To date, no agency has applied for authority to test or adopt HD Radio for any location in Canada.

More recently, the Federal Telecommunications Commission of Mexico authorized HD Radio transmission within 320 miles of the U.S. border. Recognizing ‘the extent of the

development and implementation of the IBOC system' in the U.S., COFETEL elected to forego further research and field trials in advance, taking 'decisive action' to bring HD Radio to listeners in northern Mexico (Radio 2008). Mexican regulators directed stations interested in HD transmission to request authorization and assist with assessments of the technology. Conveniently for American broadcasters, the 320 km limit accommodates the signals of stations broadcasting from San Diego, Tucson, El Paso and other metropolitan areas along the border.

## **[2] Social implications: Radio's 'third chance'?**

The British broadcaster Charles A. Siepman, who was called upon by the F.C.C. to write the well-regarded (but ultimately ignored) *Blue Book* on public service in American broadcasting, referred to the development of FM broadcasting in the 1940s as 'radio's second chance'. He wrote of the social potential of FM to redeem radio's promise after the AM band became awash in mass entertainment and advertising (Siepman 1946). If FM represented radio's second chance, might the digital transition constitute the medium's third chance?

It's clear that digital radio offers some of the same advantages noted by Siepman in the case of FM – additional channels of communication through multicasting, and improved audio quality. Satellite providers tout the availability of scores of channels, more than 170 on XM and more than 130 on Sirius (some channels were heard on both services after the merger). 'Everything worth listening to is now on Sirius,' reads the corporate slogan ([www.sirius.com](http://www.sirius.com)). Talk programming crosses the political spectrum, from the

Sirius Left channel of liberal content, to Sirius Patriot, a conservative outlet. Like oldies music? XM offers separate channels for each decade from the 1940s through the 1990s, as well as broadcasts of the Super Bowl in 10 languages, including Flemish, Hungarian and Mandarin Chinese ([www.xmradio.com](http://www.xmradio.com)).

HD Radio, while offering fewer channels because of technical limitations, nonetheless seeks to provide programme alternatives beyond the usual broadcast fare. In Portland, Oregon, for example, the 23<sup>rd</sup>-largest radio market in the U.S., fourteen broadcasters were multicasting secondary channels at this writing. Formats included blues, comedy and all Northwest rock bands ([www.ibiquity.com](http://www.ibiquity.com)), none of which would generally be considered commercially viable in a traditional analogue model.

In addition to programme diversity, digital transmission of course offers the enhancement of connectivity to the digital realm, of radio as gateway to web access and data services. Digital receivers can display song titles, news headlines and weather or traffic alerts, as well as interactivity with advertising. The commercial possibilities – such as the instant ability to push a button and buy a download of a song being played, or a product being advertised – makes digital transmission attractive to marketers. And, given the growing diffusion of third-generation mobile phones, software engineers have designed applications to allow users to listen to web streams of radio on their so-called ‘smart phones’ (Everhart 2009).

Do the potential programming, access and service benefits of digital radio, however, align with the ‘touchstone value’ of localism? In theory, the ‘digital plenty’ could allow for hyper-local, multicast channels that serve targeted geographic or ethnic communities. In practice, however, the early returns point to narrowcasting on secondary IBOC channels defined in terms of musical taste, such as the ‘indie-rock’ channels starting to proliferate on HD radio. Of course, satellite radio, as a national service, primarily construes ‘localism’ in terms of genre tastes, with the occasional exception of imagined communities such as the gay and lesbian audience served by Sirius’ OutQ channel ([www.sirius.com/outq](http://www.sirius.com/outq)).

## **[2] Supervening social necessity?**

While regulators and industry leaders invested years of energy and millions of dollars in competing digital radio systems, consumers have remained largely unimpressed. Presented with a variety of digital audio systems, the public has gravitated to iPods, smart phones and Internet audio, as indicated in the Bridge Ratings study. This reflects Winston’s notion that there must be ‘supervening social necessity’ if a technological innovation is to be widely diffused (Winston 1998). Put simply, the innovation must serve some social need if it is to succeed; a commercial purpose alone is not necessarily sufficient. The rapid acceptance of early radio can be linked to satisfying the entertainment and information needs of a dispersed and growing population, as well as commercial needs for mass marketing (Lax 2003).

In contrast, where is the consumer demand for digital radio in the U.S.? What is the ‘killer application’? Data from the Project for Excellence in Journalism indicates that the number of broadcasters switching to HD Radio peaked at in 2006 at 522 stations – the year HD became available to the public. The number of new HD stations fell 25 per cent to 394 in 2007 (Radio 2008). While the data may reflect reluctance on the part of terrestrial station owners to shoulder the burden of conversion in the present difficult economic circumstances, the downward trend may also indicate that HD Radio has passed the peak in the bell curve of technology adoption described by Rogers (2003: 273). The PEJ study sees clouds on the horizon for satellite radio as well: public awareness of satellite radio has leveled off considerably since 2006 at about 60%. Interest in satellite radio remains flat as well, with only 3% responding that they are ‘very likely’ to subscribe in the next 12 months. Concurrently, 44% said cell phones are having ‘a big impact on their lives’, and today’s smart phones are capable of receiving Internet streaming audio (including the streams of XM and Sirius), and analogue radio – but not HD Radio. In summary, it seems that analogue broadcast radio remains ubiquitous in the U.S., and hundreds of millions of receivers will work just fine for the vast majority of listeners for the foreseeable future.

What Levy wrote in the context of European digitization applies in the U.S. case: ‘Technological change tended more often to lead to minor reforms of existing institutional structures...than to be used as an opportunity for a radical overhaul of either these institutions or hitherto shared policy objectives’ (1999: 122). The lack of supervening social necessity, coupled with the absence of a government mandate to go

digital (as in the case of television), crippled the dual system approach promoted by industry and regulators. Instead, consumers wearing ear buds are driving the ‘radical overhaul’.

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## Notes

<sup>i</sup> Personal communication from Skip Pizzi, 11 May 2009.

<sup>ii</sup> “The 'HD' in 'HD Radio' does not mean 'high-definition' or 'hybrid digital'. It is part of iBiquity's brand for its digital radio technology” (iBiquity 2009).